Monitoring and Regulating Teamwork

Completed Technology Project (2012 - 2014)

Project Introduction

This ground-based research extended prior NASA supported work to address: PRD (Program Requirements Document) Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team. IRP (Integrated Research Plan) Gap - Team2: Given the context of long duration missions, what are the best tools to effectively monitor and measure task performance, teamwork, and psychosocial performance? Collaboration and cohesion are critical underpinnings of teamwork. This is especially true for high reliability teams such as long duration (LD) space flight crews that have to perform in extreme environments. Effective teamwork is essential for minimizing errors and supporting team performance, and it is reflective of good psychosocial adaptation to the stresses of LD space missions. Research Plan: This research had two key goals: (a) benchmarking variation in team collaboration and team cohesion over LD missions and (b) further developing a monitoring and regulation system to unobtrusively measure team collaboration and cohesion. For (a), there is substantial research that documents a relationship between team cohesion and effectiveness; however, that evidentiary foundation is based on static data. We are systematically examining variation in team cohesion and collaboration in LD analog teams operating in isolated, confined, and extreme (ICE) environments. In prior research we had collected preliminary data for ICE teams operating in the Antarctic and had detected evidence for considerable variation in cohesion levels over time. This project extended the research to larger samples and longer durations to help calibrate expected levels of cohesion variability, which is essential for developing appropriate models to benchmark team psycho-social health. For (b), one key component of the monitoring system is a technology--a wearable sensor network--that assesses the frequency, duration, distance, and quality of collaboration as team members work together. In prior research we had developed functional prototypes and had initiated a series of basic laboratory validation studies. That work provided preliminary validation evidence demonstrating that the monitoring technology is capable of accurately capturing team member interactions (relative to video coding of interactions) in highly structured collaborations. The current research advanced the prior research to develop the monitoring and regulation system by: (a) extending validation research of the monitoring technology to capture successively more complex and naturalistic team interaction dynamics, and (b) initiating the development of a feedback "dashboard" to display multiple data streams (collaboration frequency, duration, and distance; physiological arousal) that can help diagnose the effectiveness of collaboration and teamwork. Specific Aims: The purpose of this proposal was to (1) extend our benchmarking of LD team functioning in ICE environments, (2) extend the validation process for the monitoring and regulation system and begin to develop a data fusion model, and (3) develop a feedback dashboard to display multimodal data on team functioning. Project deliverables: (1) benchmarking data for long duration analog teams in operating in ICE environments, (2) validation

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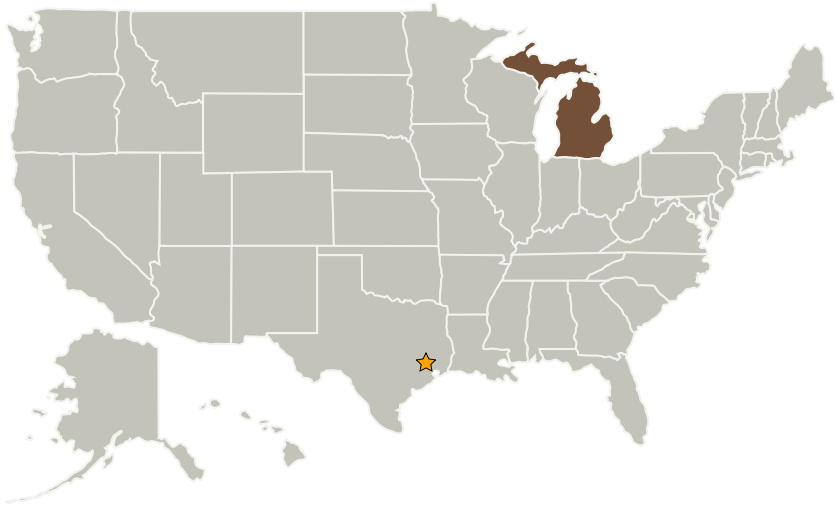
evidence to establish proof-of-concept for the monitoring technology and preliminary development of a data fusion model, and (3) a feedback dashboard display to diagnose team functioning based on multimodal monitoring data.

Anticipated Benefits

Team cohesion is not just a critical factor for astronaut teams and ground crews; cohesion is important to the effectiveness of all teams and especially those that operate in critical, high reliability settings. Of the many team process factors that support team effectiveness, team cohesion is the most studied with over a half century of research. Yet, remarkably, very little is known about the characteristics that promote its development and maintenance. For example, we know that experience working together is associated with cohesion formation and maintenance, but what are the mechanisms? Teams that do not cohere replace problematic members or disintegrate so experience only reveals those teams that survive, but that does not tell us why or how. This research stream, which is uncovering the dynamics of collaboration, cohesion, and effective team functioning and creating technologies to monitor team cohesion and guide interventions to restore it, has the potential for wide utility in aviation, military, medical, industrial, and other environments where society depends on the effective performance of high reliability teams.

Primary U.S. Work Locations and Key Partners



Organizational Responsibility

Responsible Mission Directorate:

Space Operations Mission Directorate (SOMD)

Lead Center / Facility:

Johnson Space Center (JSC)

Responsible Program:

Human Spaceflight Capabilities

Project Management

Program Director:

David K Baumann

Project Manager:

Lauren B Leveton

Principal Investigator:

Steve Kozlowski

Co-Investigators:

Chu-hsiang Chang
Subir Biswas

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Organizations Performing Work	Role	Type	Location
★Johnson Space Center(JSC)	Lead Organization	NASA Center	Houston, Texas
Michigan State University	Supporting Organization	Academia	East Lansing, Michigan

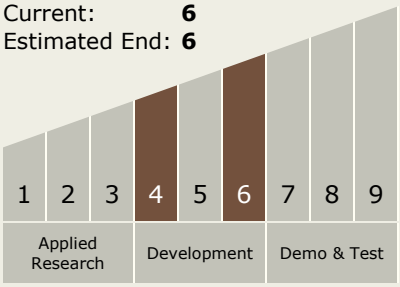
Primary U.S. Work Locations
Michigan

Project Transitions

September 2012: Project Start

Technology Maturity (TRL)

Start: **4**
Current: **6**
Estimated End: **6**



Technology Areas

Primary:

- TX06 Human Health, Life Support, and Habitation Systems
  - TX06.3 Human Health and Performance
    - TX06.3.3 Behavioral Health and Performance

Target Destinations

The Moon, Mars

September 2014: Closed out

Closeout Summary: Introduction Collaboration and cohesion are critical underpinnings of teamwork. This is especially true for high reliability teams such as long duration (LD) space flight crews that have to perform in extreme environments. Effec tive teamwork is essential for minimizing errors and supporting team performance, and it is reflective of good psychosocial adaptation to the stresses of LD space missions. Specific Aims. This ground-based research extended prior NASA supported research to address: PRD Risk of Performance Decrements Due to Inadequate Cooperation, Coordination, Communication, and Psychosocial Adaptation within a Team. IRP Gap - Team2: Given the context of long duration missions, what are the be st tools to effectively monitor and measure task performance, teamwork, and psychosocial performance? The overall goals of the research were to: (a) collect benchmark data to provide an evidentiary foundation for the dynamics of teamwork duri ng long duration missions in isolated, confined, and extreme (ICE) environments that serve as analogs for space flight and (b) extend validation and development of a wireless sensor technology designed to monitor collaborative teamwork, team f unctioning, and psycho-social health. Both goals are extensions of previously funded NASA research (NNX09AK47G). With r espect to goal (a), although there is substantial research documenting a relationship between team cohesion and team effe ctiveness, that research foundation is based on cross-sectional, static data; there is remarkably little research that docume nts the dynamics of collaboration, teamwork, and cohesion over lengthy time periods (Cronin, Weingart, & Todorova, 2011; Kozlowski & Ilgen, 2006). With respect to goal (b), a key component of the system is a monitoring technology—a wearable badge housing a sensor network—that assesses the frequency, duration, distance, and quality of collaboration as team me mbers work together. The research extended the development of the monitoring, measurement, and regulation system by accomplishing three specific aims to: (1) benchmark the dynamic interaction and collaboration patterns of teams in ICE env ironments using longitudinal diary studies with teams deployed in NASA analog environments, (2) extend validation researc h of the monitoring technology to capture successively more complex and naturalistic team interaction dynamics, and (3) in itiate the development of feedback and data fusion models to display and integrate multi-modal data streams (i.e., collabor ation frequency, duration, and distance; physiological arousal) that can be used to diagnose the effectiveness of collaborati on and teamwork. Note that in the Task Book version of this report, Figures and Tables that document primary findings are excluded. However, those details of the research are contained in the project final report. LD Benchmarking Data for ICE Te ams Overview. The first specific aim for the project was to benchmark the collaboration patterns of teams in an ICE analog environment using experience sampling methodology (ESM; daily diary reports of team functioning). As noted previously, al though there is considerable research on the relationship between team cohesion and other "team processes" that reflect th e quality of member interactions, most of the data are collected using cross-sectional designs and are therefore static. It is likely that collaboration patterns and interaction quality vary as a team forms, develops, and interacts over lengthy time fra mes. Long duration teams have to manage work-related problems and occasional social friction (Tekleab, Quigley, & Teslu k, 2009), yet little is known about such dynamics because the majority of team process research has been conducted at jus t one or two time-points (Casey-Campbell & Martens, 2009; Cronin et al., 2011). Our prior research collected ESM data fro m two science team missions during their 2010-2011 and 2011-2012 deployments to the Antarctic (6 weeks camped on the ice) (Kozlowski, Biswas, & Chang, 2013). Those preliminary data indicated that patterns of cohesion varied over time across teams, and that different triggering events were associated with either positive or negative changes in team members' inter action reports. Those findings indicated that team cohesion (and other "team process") perceptions were sensitive indicator s of variation in the quality of team functioning. Our goal for this project was to continue the research effort to collect indivi dual differences (i.e., personality factors), team process, and team outcome data from ICE analog teams to better understa nd the factors that influence the collaboration patterns in these teams, and how changes in collaboration relate to the team performance. Benchmarking data of team interaction dynamics are important for calibrating the interpretation of data strea ms that will be captured by the monitoring technology (Specific Aim 2) and feedback (Specific Aim 3) systems. Thus, we co ntinued the ESM data collections with Antarctic science teams during their 2012-2013 deployment. Methods and findings fro m this research are reported below. In addition, we submitted a proposal to the Australian Antarctic Division (AAD) for para llel research to be conducted at Mawson, Davis, and Casey AAD Stations for winter over missions. AAD station teams offere d the potential for long duration missions (Austral winter) and a larger sample of individuals and teams. That research was approved by AAD. We initiated data collection under this grant and our collaboration with AAD is ongoing. Findings from the AAD LD ICE research will be reported under a superseding NASA grant. Methods. Eight people took part in the 2013-2014 A ntarctic mission (six members and two leaders). Prior to deployment, the scientific team members completed a pre-expediti on survey that included items assessing their background and individual differences (e.g., personality, teamwork skills). Du ring the six-week mission when the team deployed to the Antarctic ice, members completed daily diary surveys that asked them to reflect on their feelings and thoughts with regard to their team and personal experiences. Finally, members comple ted a post-expedition survey to evaluate their overall experience after they returned from the mission. A full report of these

Stories

Abstracts for Journals and Proceedings
(https://techport.nasa.gov/file/38091)

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(https://techport.nasa.gov/file/38094)

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Project Website:

https://taskbook.nasaprs.com